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Sharing of the Output Current of A Voltage Source Inverter between Controlled Switches and Anti-parallel Diodes

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***Abstract*— When a two level VSI feeds an induction motor, the motor current is almost sinusoidal though the voltages at the terminals have substantial high frequency harmonics. Further the load current is shared between the controlled switch and the antiparallel diodes .These essential features of a two level VSI are studied in this paper using MATLAB simulation.**

***Index Terms*—Balanced two phase induction motors, switching function, SPWM .**

I. Introduction

Use of semiconductor switches to invert a d.c. input supply into a balanced two-phase or three phase systems with variable voltage and frequency output is well established [4,5].It has to be realized that the components of the inverter must have a rating commensurate with the the load (is very often an induction motor) it is supposed to feed. MATLAB simulation has been used very intensively for this purpose [1,2].This paper follows the trail by using MATLAB simulation in connection with a two phase balanced induction motor. Various topologies of inverters are possible for feeding such a motor [3].However this paper restricts itself to only one of them in which two half bridges are used to generate a two phase supply . The first step in the analysis of this topology using switching function is reported in [6].This paper suggests a rather novel way of implementing switching functions to decompose the total load current into components flowing through different switch elements constituting the half bridges.

II. System Used For Simulation

The system used for simulation is shown in fig.1 The circuit used in fig.1 is an inverter using two half bridges. It consists of four switches and a center –tapped d.c. link supplied by a diode. rectifier .The circuit also shows the two phase motor with two windings á and â. The two windings are arranged spatially at 90 degree electrical on the stator. Two terminals of the two windings are connected at point N which is connected to O. The switches are operated in a sequence decided by sinusoidal pulse width modulation (SPWM).The sequential operation of switches give rise to two voltages 90 degree electrically apart

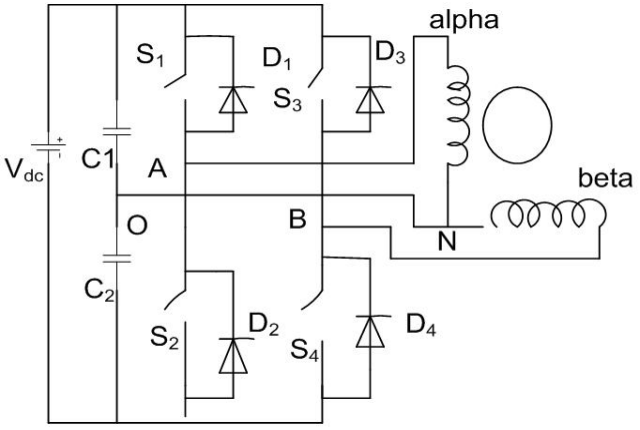

Fig 1. The system used for simulation

III. Simulation of the voltage and current outputs Vα,Vβ , Iα,Iβ for the converter

This has been discussed in detail by the present authors [6] The relevant block diagrams are presented here for ready reference.(fig.2 and fig.3)

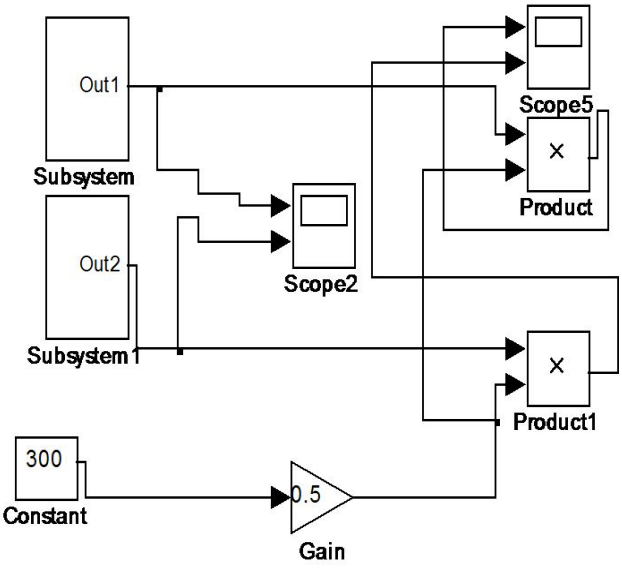

Fig2. Blocks from MATLAB for simulation of Vα,Vβ

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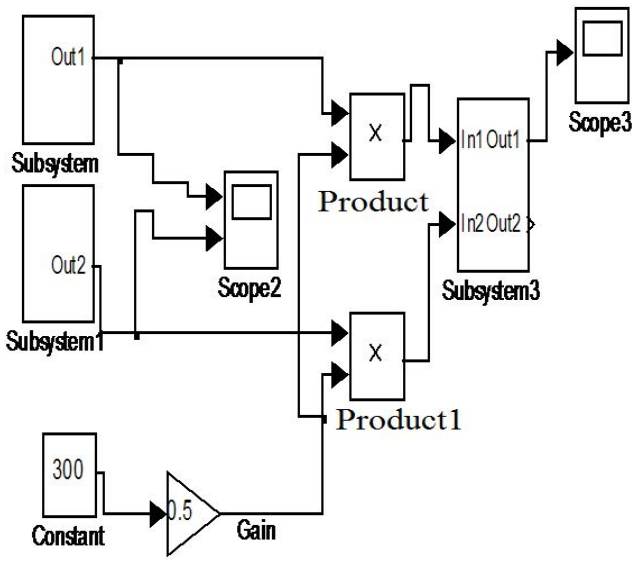

Fig. 3 Blocks from MATLAB for simulation of I_α and I_β

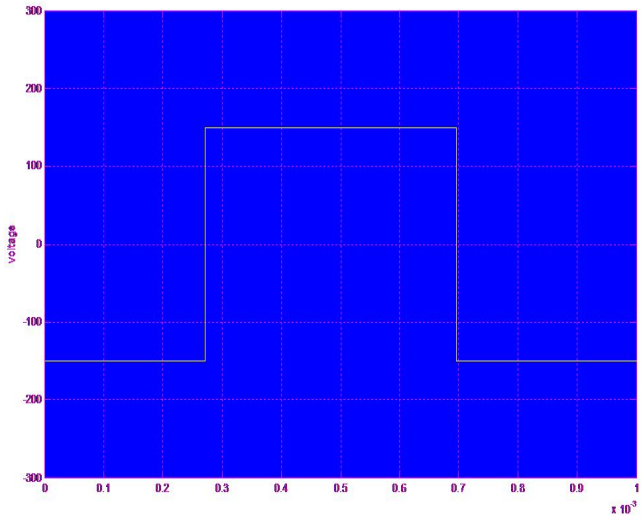

Fig.4 Simulated V_α

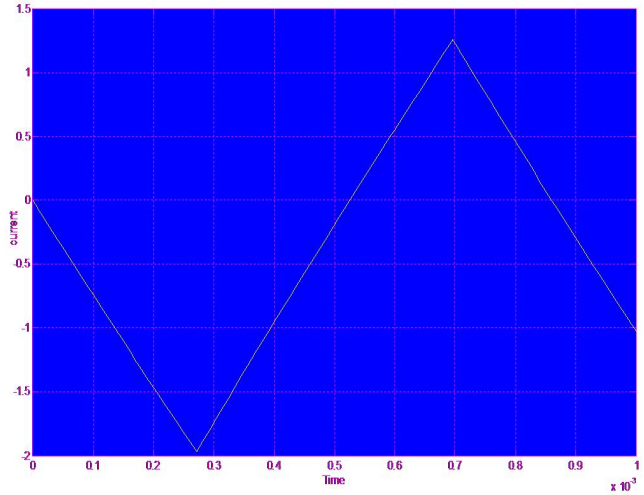

Fig.5 Simulated I_α

Fig 4 and fig.5 shows the single cycle for voltage V_α and the current I_α

IV. Implementation of switching functions

From the waveform of the input voltages (fig.4)and the output current waveforms (fig.5) it is seen that the input voltage can either be positive or negative .Similarly the output current is either negative or positive .Considering phase á only as an example the fig6 shows ,the circuit situations for four conditions possible

1) +ve V_α -veI_α
2)+ve V_α +veI_α
3) -ve V_α +veI_α
4) -ve V_α -veI_α

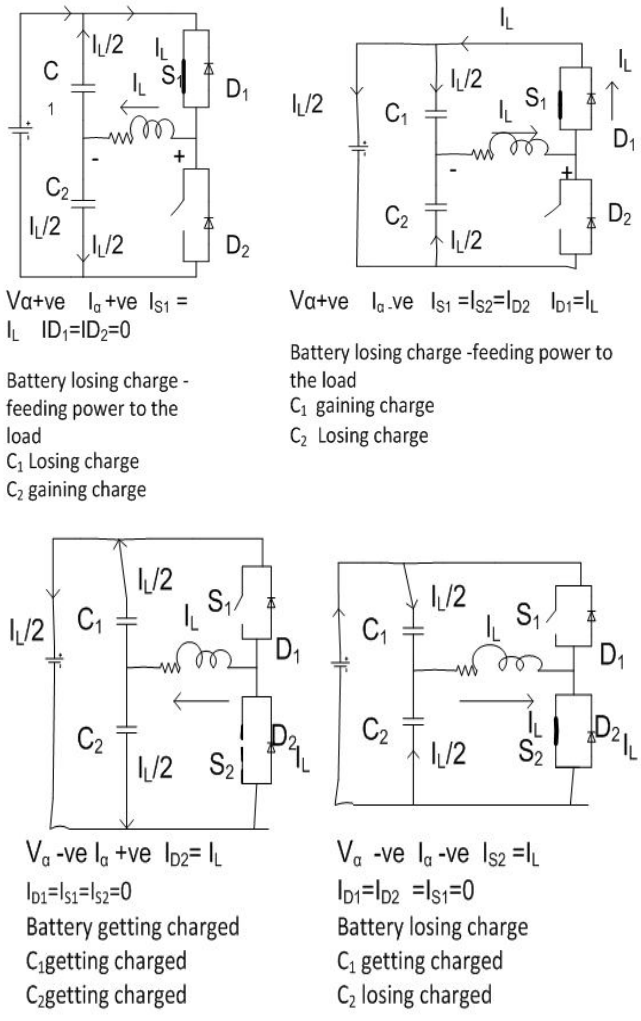

Fig6. Circuit situation for four possible conditions

The configurations clearly show that for the four situations shown the load current IL flows in S1,D1,D2,andS2 respectively

The respective component currents can be implemented as follows.

$$IS_1 = I^* SFS_1$$
$$ID_1 = I^* SFD_1$$
$$ID_2 = I^* SFD_2$$
$$IS_2 = I^* SFS_2$$

The implementation of SFS1,SFD1,SFD2,SFS2 and the multiplication is shown in fig. 7

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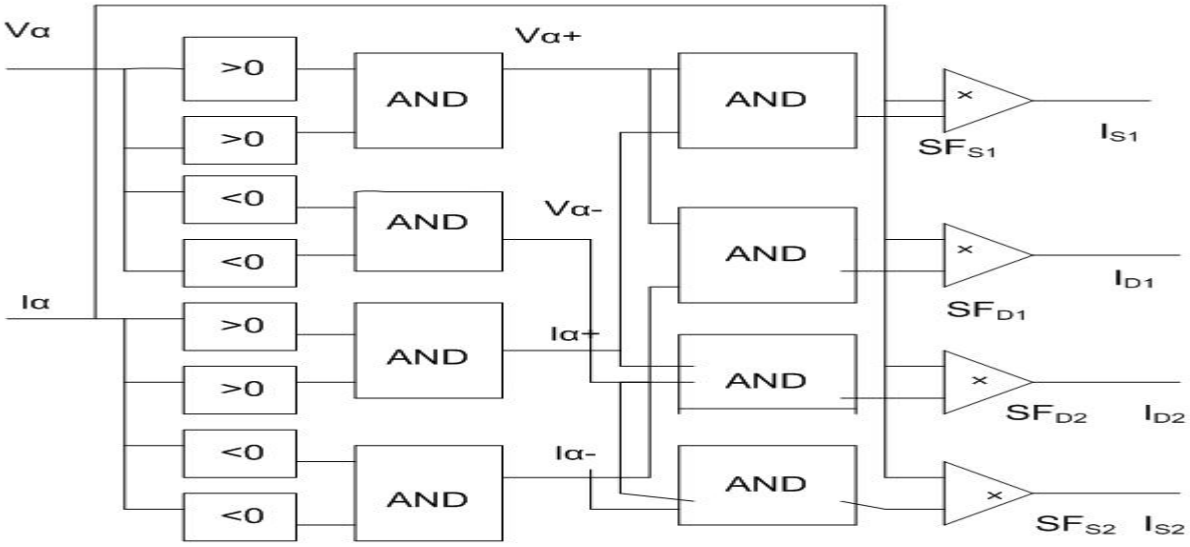

Fig.7 The switching functions SFS1,SFD1,SFD2,SFS2

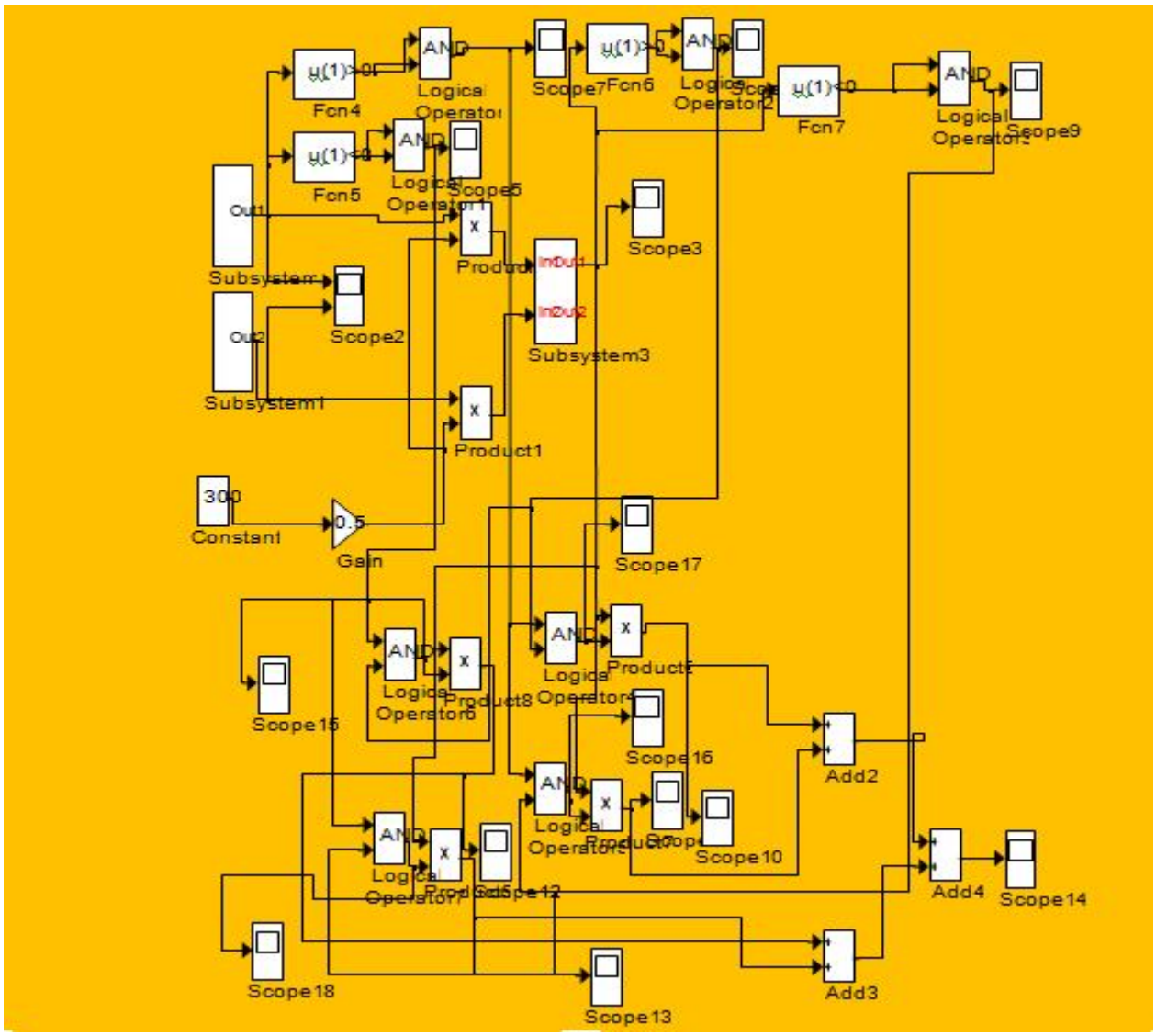

Fig8 Connection of MATLAB blocks for switching functions and the corresponding currents

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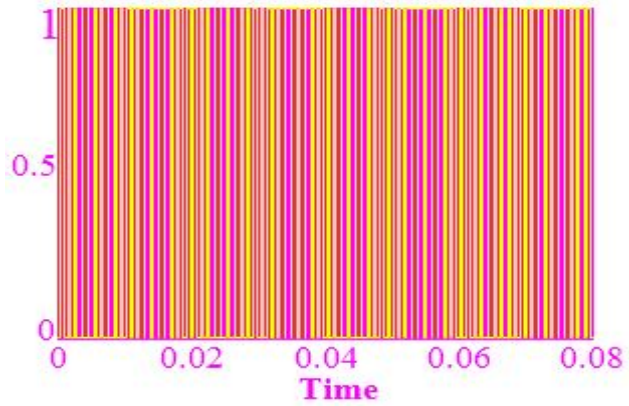

Fig 9 (a) Switching function for current through S_1

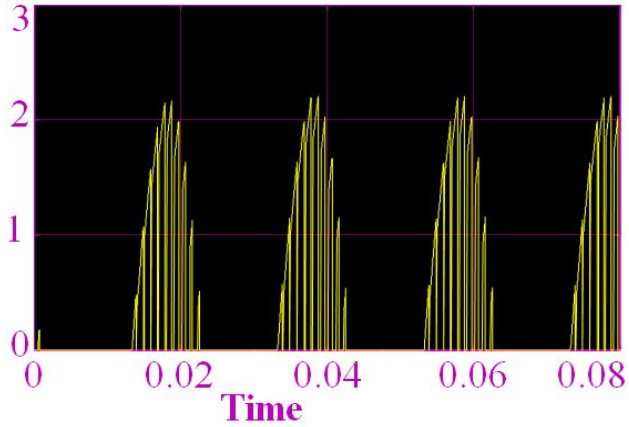

Fig 9 (b) Current through S_1

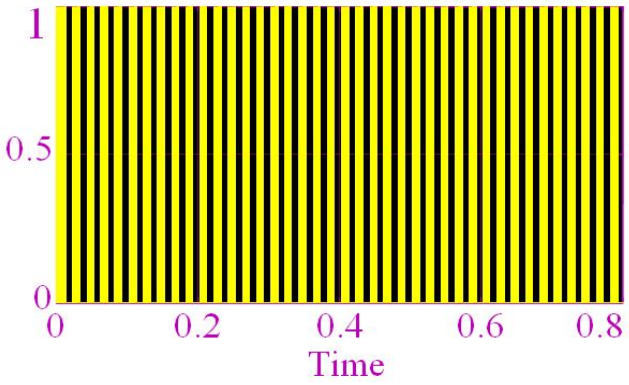

Fig 9 (c) Switching function for current through diodeD_1

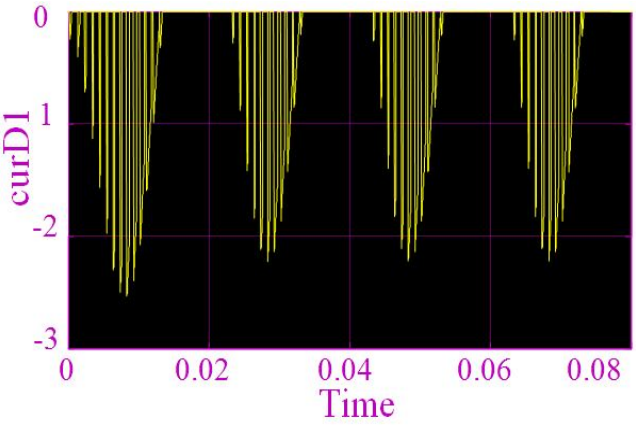

Fig 9 (d) Current through diode D_1

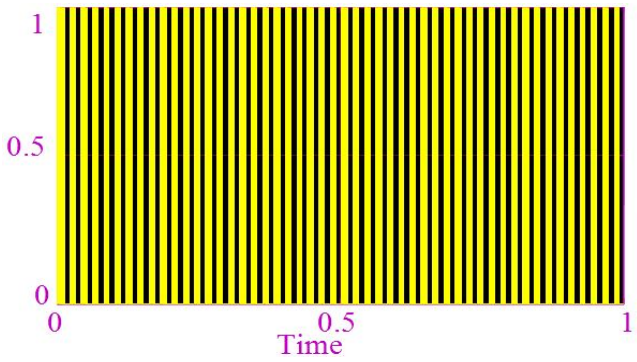

Fig 9 (e) Switching function for current through Diode D_2

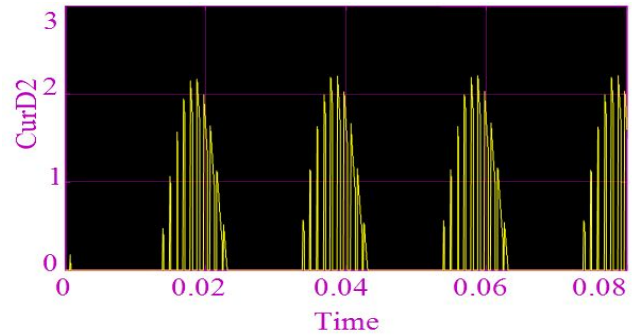

Fig 9 (f) Current through the diode D_2

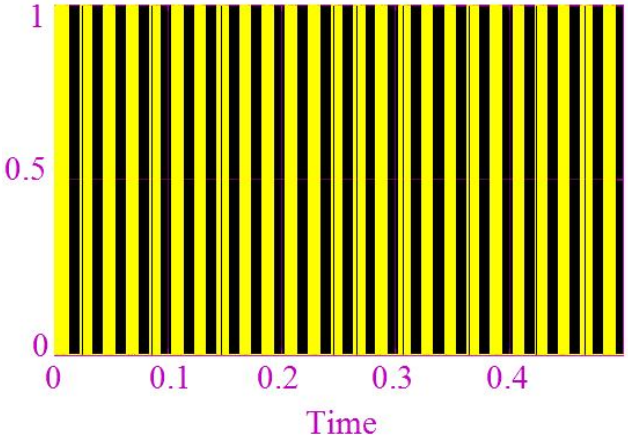

Fig 9 (g) Switching function for current through switch S_2

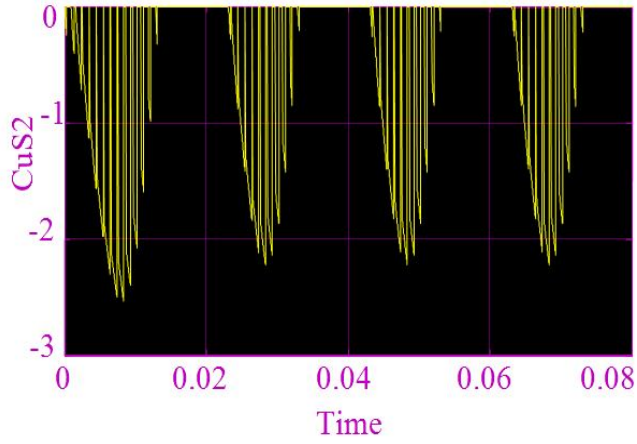

Fig 9 (h) Current flowing through S_2

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Phase β has same current shifted by 90 degree. The ratings of the switches can be found from the waveforms simulated in fig 9 for the worst possible condition of motor.

V. Parameters used for simulation

Carrier frequency is 1KHZ. Modulation index is 0.8
Input Voltage =300v. Model load has a fixed resistance of R=31.95Ω, L=158 mH.

VI. Discussion and analysis of the simulation

The analysis shows that the rms values of current needed to be fed through the controlled switch and through the freewheeling diode can be separately calculated because of the use of switching function.

VII. Conclusion

MATlAB simulation helps us in calculating the ratings of the inverter switches .it is also seen that the use of switching function technique gives a better insight into the working of inverter.

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